November 1995 Highlights of the Pulsed Power Inertial Confinement Fusion Program

New facility for NIF switch development tests.

Invited and contributed talks were given at the APS Division of Plasma Physics Meeting. We summarized recent efforts in pulsed power ICF, including: 1) hybrid (particle-fluid) simulations by Dale Welch of Mission Research that indicate, in agreement with SABRE experiments, significant improvement in lithium beam purity if thermal desorption and breakdown of contaminants are controlled by heating and cleaning electrode surfaces prior to the power pulse; 2) methods to improve ion emission uniformity in extraction geometries; 3) how to limit growth of ion divergence near the ion emission region and during acceleration in the diode; 4) analysis of lithium hohlraum experiments in cylindrical and conical geometry; and 5) experiments and simulations of magnetohydrodynamic Rayleigh-Taylor instability growth in annular- and solid-fill gas puff implosions.

This month we initiated changes to the extraction (PBFA-X) configuration to study ion beam generation in the high-voltage (15-MV) mode using the top and bottom halves of PBFA II in series. Power flow evaluation, diagnosis, and calibration were done with short circuit shots prior to beginning the higher voltage operating point. We are in a new regime with respect to the total magnetic forces on the field coil assemblies, which were previously designed for balanced, peak pressures in a radially-focusing rather than an extraction geometry. Initial coil failures have been corrected, and the robustness of the hardware is being improved to account for the additional stresses.

A Tri-lab (SNL, LLNL, LBL) discussion was held at Livermore to plan complementary and collaborative research efforts in three areas common to the light and heavy ion ICF programs. The working groups on accelerator concepts and targets are just being formed. The beam transport working group has existed for more than a year. It has considered a single facility--using middle-weight ions--to produce high yield to satisfy both defense and energy missions is coordinating progress in understanding light and heavy ion beam transport, and is now producing a white paper for distribution including Defense Programs and Energy Research at the Department of Energy. The high specific power deposition of light ion beams (1400 TW/g for lithium demonstrated in 1994) will allow us to investigate the physics of ion beam/material interaction at levels near those required for a high yield facility (1000 - 7000 TW/g).

The inadequacy of existing sources is a major impediment to increasing ion beam brightness in diode experiments. An interdisciplinary workshop on the physics of high-currrent-density ion sources will be held December 11-12 at Sandia to 1) define the necessary source parameters for a high yield facility ion diode, 2) review the experimental status and future promise of existing ion sources, 3) define the diagnostic requirements for measuring key parameters, and 4) review the theory and simulations of ion sources.

Sandia has primary responsibility for the power conditioning system for the National Ignition Facility. The largest technical challenge is development of a switch that can conduct a 24-kV, 500-kA, 360-µs pulse and that has a reaonable lifetime. No commercial switch presently exists that can meet all of the NIF requirements. A switch test stand (see figure) is now nearing completion where the Demon facility used to be, and switch testing should begin in January.

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